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(54) **Magnetic ring for detecting the rotation of an object.**

(57) A ring (1, 1') to be attached to a rotary body - (42) for producing a magnetic signal in cooperation with a magnetic sensor (38) relative to which the rotary body rotates, comprising: a magnetic ring member (2, 12, 22, 32) having an alternating magnetic property around a circumference thereof and made of synthetic resin in which magnetic material is dispersed; and a reinforcing ring member (3, 13, 23, 33) which is made of synthetic resin material and is substantially circumferentially coextensive with the magnetic ring member. Alternatively, the reinforcing ring may consist of a metallic band (24) which extends around the circumference of the ring. By thus reinforcing the resinous magnetic material, the cost of the ring can be reduced on the one hand and the increased mechanical strength of the ring allows easy handling and effective press fitting of the ring on the other hand. By forming the ring as a plurality of arcuate segment portions (2a, 2b 3a, 3b, 12a, 12b, 13a, 13b, 22a, 22b, 23a, 23b, 32a, 32b, 33a, 33b) the stocking and installing of the ring is facilitated.

Fig. 3

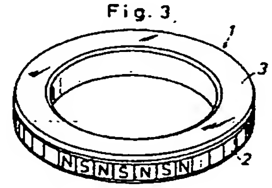
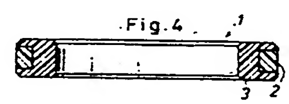


Fig. 4



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"MAGNETIC RING FOR DETECTING THE ROTATION OF AN OBJECT"

The present invention relates to a magnetic ring for detecting the rotation of an object and in particular to such a magnetic ring making use of synthetic resin material in which magnetic particles are dispersed.

It is often necessary to electrically detect the rotation or rotational speed of an object. For instance, it is often desired to measure the rotational speed of a shaft in industrial applications and it is often desirable to measure the rotational speed of a wheel in automotive applications. For instance, in evaluating the speed of an automobile, one can obtain a highly accurate speed reading by measuring the rotational speed of a wheel itself, and it is absolutely necessary to measure the rotational speed of a wheel in anti-skid control of a brake system.

In such applications, it has been common to use a toothed gear which is mounted on a rotating object and to measure its rotational speed by counting pulses generated from a magnetic induction device placed adjacent to the toothed gear. Since such a toothed gear is typically press fitted into a bore or onto a shaft, it must be capable of withstanding the stress arising from such a press fitting and it is typically made of metal such as steel. Since hobbing of a gear which is a fairly time consuming and expensive process is necessary and a substantial dimensional precision is necessary for satisfactory press fitting, such a metallic ring for detecting rotational speed tends to be costly.

Magnetic material consisting of synthetic resin in which ferromagnetic powder is dispersed is known and it can be formed into a ring having a plurality of gear teeth or magnetized to have alternating magnetic poles around its circumference at very low cost. Furthermore, it is substantially lighter in weight than a conventional toothed gear ring made of steel. However, such material lacks the mechanical strength required for press fitting. Such material, particularly in the form of a toothed gear, is prone to damage during an assembly process and in use, and its reliability and durability are insufficient for practical purposes.

Viewed from one aspect the present invention provides a ring to be attached to a rotary body for producing a magnetic signal in cooperation with a magnetic sensor relative to which the rotary body rotates, comprising: a magnetic ring member having an alternating magnetic property around a circumference thereof and made of synthetic resin in which magnetic material is dispersed; and a reinforcing ring member which is made of synthetic resin material and is substantially circumferentially coextensive with the magnetic ring member.

The said resinous magnetic ring member having a magnetically alternating property around a circumference thereof may consist of a ferromagnetic ring having alternating magnetic poles along its inner circumference, outer circumference or end surface, which is made by molding composite magnetic material which is in turn made by uniformly mulling synthetic resin material such as polyamide, polyolefin and ethylene copolymer materials with magnetic powder such as barium ferrite, strontium ferrite or rare earth magnetic powder, optionally with some additives.

Such a resinous permanent magnet ring member may typically have ten or more N and S poles, and preferably 50 to 200 poles around its circumference. The weight ratio of the synthetic resin (I) to the magnetic powder (II) in this composite magnetic material may be (I)/(II) = 40/60 to 5/95, preferably (I)/(II) = 20/80 to 8/92.

Preferably, this resinous permanent magnet ring member is embedded in a synthetic resin ring for reinforcement to endow the thus formed ring with the mechanical strength and integrity which are necessary for press fitting and easy handling. The material, for this synthetic resin ring may consist of, for instance, polyethylene, polypropylene, polyvinyl chloride, styrene-butadiene copolymer, AS resin, ABS resin, polyamide, polyacetal, polycarbonate, polyethylene phthalate, polyphenylene sulfide, polyphenylene ether, polysulfone, thermoplastic polyurethane, etc. It is preferable to reinforce such synthetic resin with glass fiber or other reinforcing material. It is also possible to reinforce the synthetic resin ring with a metallic ring, extending around its full circumference, which may be press fitted to or insert molded with the synthetic resin ring.

Alternatively, such a resinous permanent magnet ring member having alternating magnetic poles around its circumference may be replaced by a toothed gear ring having a magnetic property and having a plurality of teeth around its inner circumference, outer circumference or end surface, which is made by molding composite magnetic material which is in turn made by uniformly mulling synthetic resin material such as polyamide, polyolefin or ethylene copolymer materials with magnetic material such as soft ferrite, iron, iron alloy or nickel alloy powder, optionally with some additives. The magnetic permeability of this magnetic material may be 5.0 or greater, preferably 10.0 or greater.

A ring according to the invention may be polygonal in shape so as to prevent it from slipping relative to an object to which the ring is fitted.

In an alternative form of the invention, the reinforcing ring member may be made of metal or alloy material, instead of synthetic resin, extending around the circumference of the magnetic ring member.

Thus viewed from a further aspect the invention provides a ring to be attached to a rotary body for producing a magnetic signal in cooperation with a magentic sensor relative to which the rotary body rotates, comprising: a magnetic ring member having an alternating magnetic property around a circumference thereof and made of synthetic resin in which magnetic material is dispersed; and a reinforcing ring member which is made of metal or alloy material and is substantially circumferentially coextensive with the magnetic ring member.

Viewed from yet another aspect the invention provides a ring to be attached to a rotary body for producing a magnetic signal in cooperation with a magnetic sensor relative to which the rotary body rotates, comprising: a magnetic ring member having an alternating magnetic property around a circumference thereof and which comprises at least two arcuate segments, forming a complete circle through mutual cooperation therebetween, and made of synthetic resin in which magnetic material is dispersed; and fastening means for holding the arcuate segments together in the state of a complete ring. This not only facilitates the work involved in assembling and replacing the ring but also improves the convenience in stocking such rings as component parts.

Some embodiments of the invention will now be described by way of example and with reference to the accompanying drawings, in which:-

Figure 1 is a sectional view of a non-driven wheel of a four-wheel automobile equipped with a magnetic ring for detecting the rotation of the wheel, according to the present invention;

Figure 2 is an illustrative view showing the principle of detecting the rotation of a wheel using a magnetic ring having alternating magnetic poles, according to the present invention;

Figure 3 is a perspective view of an embodiment of a magnetic ring according to the present invention;

Figure 4 to 13 are sectional views showing different embodiments of a magnetic ring having alternating magnetic poles around its circumference, according to the present invention;

Figure 14 is an illustrative view showing the principle of detecting the rotation of a wheel using a magnetic ring having alternating magnetic poles around its end surface, according to the present invention;

Figures 15 and 16 are a perspective view and a sectional view of the magnetic ring of Figure 14, respectively;

Figure 17 is an illustrative view showing the principle of detecting the rotation of a wheel using a magnetic ring having gear teeth around its circumference, according to the present invention;

Figures 18 and 19 are a perspective view and a sectional view of the magnetic ring of Figure 17, respectively;

Figures 20 to 30 are sectional views showing different embodiments of a magnetic ring having gear teeth around its circumference, according to the present invention;

Figure 31 is an illustrative view showing the principle of detecting the rotation of a wheel using a magnetic ring having crown gear teeth around its end surface, according to the present invention;

Figures 32 and 33 are a perspective view and a sectional view of the magnetic ring of Figure 31, respectively;

Figures 34 and 35 are a perspective view and a sectional view of yet another embodiment of a magnetic ring according to the present invention, respectively;

Figures 36 and 37 are a perspective view and a sectional view of yet another embodiment of a magnetic ring according to the present invention, respectively;

Figures 38 and 39 are a perspective view and a sectional view of yet another embodiment ofa magnetic ring according to the present invention, respectively;

Figures 40 to 63 are sectional views showing different embodiments of a magnetic ring having a metallic reinforcement ring around its circumference, according to the present invention;

Figure 64 is an exploded perspective view of an embodiment of a magnetic ring consisting of a pair of semicircular halves, according to the present invention;

Figures 65 to 76 are sectional views of different embodiments of a magnetic ring consisting of a pair of semicircular halves, according to the present invention;

Figure77 is a perspective view of a fastener which may be used to combine the two halves of a magnetic ring according to the present invention; and

Figure 78 is a plan view of a magnetic ring having a polygonal inner circumferential surface,according to the present invention.

Figure 1 shows a structure for supporting a nondriven wheel of an automobile to which a magnetic ring for detecting the rotation of a wheel according to the present invention can be applied. The central portion of a wheel disc 42 having a flange 41 for a disc brake system is integrally

provided with an annular boss 43 which projects inwardly towards the center of the automobile. The inner circumferential surfaces of a central bore of this boss 43 is rotatably supported by the free end of an axle shaft 47 by way of a pair of tapered roller bearings 45 and 46. Further, a nut 48 is threaded to the outer most part of the free end of this axle shaft 47 by way of a washer 49 and holds the mentioned component parts together. Numeral 44 denotes one of a number of stud bolts for securing a wheel, not shown in the drawing, to the wheel disc 42.

A ring for magnetically detecting the rotation of a wheel according to the present invention may be fitted either onto the outer circumferential surface 43a of the boss 43 as denoted by numeral 1 or into an inner circumferential surface 42a of a bore of the wheel disc 42 as denoted by numeral 1', and a magnetic sensor 38 is fixedly secured to a car body portion adjacent to the ring 1, 1'.

Figure 2 is an illustrative view showing the working principle of a magnetic ring for detecting the rotation of an object according to the present invention. The ring 1 is provided with alternating magnetic poles at an equal interval around its outer circumferential surface, while the magnetic sensor 38 comprises a C-shaped iron core 39 and a coil 40 wound on this iron core 39. Therefore, as the ring 1 rotates with the wheel disc 42, a train of electric current pulses corresponding to the number of magnetic poles passing through the vicinity of the iron core 39 are induced in the coil 40 and the rotational speed of the ring 1 or the wheel disc 42 can be evaluated by counting these pulses.

Figures 3 and 4 show a first embodiment of a ring for detecting the rotation of an object according to the present invention. According to this embodiment, a permanent magnet ring 2 which is magnetized so that N and S poles appear alternatingly along its outer circumferential surface is embedded in the middle part of the outer circumferential surface of a synthetic resin ring 3.

The permanent magnet ring 2 may be made by press forming or extruding resin material containing ferromagnetic powder dispersed therein in a magnetic field into a magnetically either isotropic or anisotropic state, and demagnetizing it. Thereafter, this resinous magnetic ring 2 is placed in a metallic die and is integrally molded with a synthetic resin compound such as polyphenylene sulfide resin compound, preferably containing reinforcing material such as glass fiber, by compression molding or injection molding. Thus, the permanent magnet ring 2 is embedded in the synthetic resin ring 3. Then, the resinous permanent magnet ring 2 is magnetized according to a desired magnetization pattern with a magnetizer.

Since the permanent magnet ring 2 is embedded in the synthetic resin ring 3 which has a much greater mechanical strength than the permanent magnet ring 2, the ring 1 for detecting rotation has a sufficient mechanical strength to be press fitted onto the shaft 47 as denoted by numeral 1 in Figure 1. Furthermore, the ring 1 thus formed is much lighter in weight than a similar conventional ring made of steel or other metallic or oxide materials.

In the following description of the different embodiments of the present invention, those parts corresponding to the previously described embodiments are denoted by like numerals and their detailed description is omitted since such description would be redundant and a person skilled in the art would not be hindered by such an omission in understanding the present invention.

According to the embodiment shown in Figure 5, a metallic ring 4 for reinforcement covers the whole inner circumferential surface of a synthetic resin ring 3, made of synthetic resin material optionally containing reinforcing material such as glass fiber, in which a resinous permanent magnet ring 2 is embedded in a manner similar to that in the embodiment shown in Figures 3 and 4. The metallic ring 4 may be attached to the ring 1 for instance by insert molding and a groove 4a provided in the metallic ring 4 assures a strong bond between the metallic ring 4 and the synthetic resin ring 3. Therefore, this embodiment provides an extremely high mechanical strength for press fitting.

Figure 6 shows yet another embodiment of the present invention and, according to this embodiment, a metallic ring 4 having relatively small thickness is embedded in the inner circumferential surface of a synthetic resin ring 3 in which a permanent magnet ring 2 is embedded.

In the embodiment shown in Figure 7, a metallic ring 4 for reinforcement is attached to an end surface of a synthetic resin ring 3 having a permanent magnet ring 2 embedded in the outer circumferential surface thereof, and holes 4a provided in the metallic ring 4 assure secure bonding between the metallic ring 4 and the synthetic resin ring 3.

In the embodiment shown in Figure 8, a pair of metallic rings 4 are attached to either end surface of a synthetic resin ring 3 in which a resinous permanent magnet ring 2 is embedded in a manner similar to that in the embodiment shown in Figure 7, and holes 4a provided in these metallic rings 4 assure secure bonding between the metallic rings 4 and the synthetic resin ring 2.

In the embodiment shown in Figure 9, a cushion or buffer layer 5 which may be made of, for instance, natural or synthetic rubber such as silicone rubber is interposed between a synthetic res-

in ring 3 and a resinous permanent magnet ring 2. This cushion layer 5 protects the resinous permanent magnet ring 2 from the stress caused in the synthetic resin ring 3 when this ring 1 is press fitted, by shutting off the transmission of stress from the synthetic resin ring 3 to the resinous magnetic ring 2.

In the embodiment shown in Figure 10, a resinous permanent magnet ring 2 is embedded and wholly buried in the central portion of a synthetic resin ring 3. Therefore, according to this embodiment, the permanent magnet ring 2 is very well protected from the influences of external elements.

In the embodiment shown in Figure 11, a resinous permanent magnet ring 2 is embedded in the outer circumferential surface of a synthetic resin ring 3 and is further surrounded by a metallic ring 5 which not only protects the resinous permanent magnet ring 2 but also increases the overall mechanical strength of the ring 1.

The embodiments which have been described so far are adapted to be fitted onto a shaft as denoted by numeral 1 in Figure 1.

In the embodiment shown in Figure 12, a resinous permanent magnet ring 2 is embedded in the inner circumferential surface of a synthetic resin ring 3. The ring 1 of this embodiment is adapted to be fitted into a bore as denoted by numeral 1' in Figure 1.

In the embodiment shown in Figure 13, an end surface of a synthetic resin ring 3 has an annular step 3a and a resinous permanent magnet ring 2 having an inner circumferential surface that is magnetized into N and S poles in an alternating manner is embedded in the vertical wall surface of this annular step 3a. The ring 1 of this embodiment is adapted to be fitted onto an outer circumferential surface of a rotating object at its inner circumferential surface 1a having a smaller diameter that the vertical wall surface of the annular step 3a.

Figure 14 shows yet another embodiment of the present invention in which alternating magnetic poles appear in an end surface of a ring 1 for detecting the rotation of an object and, therefore, a magnetic sensor 38 comprising a C-shaped iron core 39 and a coil 40 wound thereon is disposed adjacent to the end surface of the ring 1. Figures 15 and 16 show the ring 1 of Figure 14 in greater detail.According to this embodiment, a resinous permanent magnet ring 2 which is magnetized so that N and S poles appear alternatingly around its circumference is embedded in the end surface of a synthetic resin ring 3. The resinous permanent magnet ring 2 is trapezoidal in cross section and is thus positively attached to the synthetic resin ring 1.

Figure 17 shows yet another embodiment of the present invention in which a plurality of gear teeth 12a are formed around the outer circumferential surface of a ring 1 for detecting the rotation of an object and, therefore, a magnetic sensor 38 comprising an iron core 39 made of a permanent magnet and a coil 40 wound thereon is disposed adjacent to the outer circumferential surface of the ring 1. Figures 18 and 19 show the ring 1 of Figure 17 in greater detail. According to this embodiment, a resinous magnetic ring 12 which consists of synthetic resin material such as polyamide and magnetic material such as ferrite dispersed therein is formed into a toothed gear having the teeth 12a and is embedded in the outer circumferential surface of a synthetic resin ring 13 which may be made of polypropylene. The inner circumferential surface of the synthetic resin ring 13 is adapted to be press fitted onto a rotating object such as the shaft 47 shown in Figure 1.

According to the embodiment shown in Figure 20, a metallic ring 14 for reinforcement covers the whole inner circumferential surface of a synthetic resin ring 13 in which a resinous magnetic ring 12 having a plurality of gear teeth 12a is embedded in a manner similar to that of Figures 18 and 19. The metallic ring 14 may be attached to the synthetic resin ring 13 for instance by insert molding and a groove 14a provided in the metallic ring 14 assures a strong bond between the metallic ring 14 and the synthetic resin ring 13. Therefore, this embodiment provides an extremely high mechanical strength for press fitting.

Figure 21 shows yet another embodiment of the present invention and, according to this embodiment, a metallic ring 14 having relatively small thickness is embedded in the inner circumferential surface of a synthetic resin ring 13, but this embodiment is otherwise similar to that shown in Figure 20.

In the embodiment shown in Figure 22, a metallic ring 14 for reinforcement is attached to an end surface of a synthetic resin ring 13, and holes 14a provided in the metallic ring 14 assure secure bonding between the metallic ring 14 and the synthetic resin ring 13. Otherwise, this embodiment is similar to that shown in Figure 21.

In the embodiment shown in Figure 23, a pair of metallic rings 14 are attached to either end surface of a synthetic resin ring 13, and holes 14a provided in these metallic rings 14 assure secure bonding between the metallic rings 14 and the synthetic resin ring 13. Otherwise, this embodiment is otherwise similar to that shown in Figure 22.

In the embodiment shown in Figure 24, a cushion or buffer layer 15 which may be made of, for instance, natural or synthetic rubber such as silicone rubber is interposed between a synthetic res-

in ring 13 and a resinous magnetic ring 12. This cushion layer 15 protects the resinous magnetic ring 12 from the stress caused in the synthetic resin ring 13 when this ring 1 is press fitted, by shutting off the transmission of stress from the synthetic resin ring 13 to the resinous magnetic ring 12.

In the embodiment shown in Figure 25, a resinous magnetic ring 12 is embedded and wholly buried in the central portion of a synthetic resin ring 13. Therefore, according to this embodiment, the toothed resinous magnetic ring 12 is very well protected from the influences of external elements.

In the embodiment shown in Figure 26, a resinous magnetic ring 12 is embedded in the outer circumferential surface of a synthetic resin ring 13, and is further surrounded by a metallic ring 14 which not only protects the resinous permanent magnet ring 12 but also increases the overall mechanical strength of the ring 1.

In the embodiment shown in Figure 27, a resinous magnetic ring 12 is embedded in the inner circumferential surface of a synthetic resin ring 13. The ring 1 of this embodiment is adapted to be fitted into a bore as denoted by numeral 1' in Figure 1.

In the embodiment shown in Figure 28, an end surface of a ring 1 made of synthetic resin has an annular step 13a and a resinous magnetic ring 12 having an inner circumferential surface that is provided with gear teeth 12a is embedded in the vertical wall surface of this annular step 13a. The ring 1 of this embodiment is adapted to be fitted onto an outer circumferential surface of a rotating object at its inner circumferential surface 1a having a smaller diameter that the vertical wall surface of the annular step 13a.

The embodiment shown in Figure 29 is similar to that shown in Figure 24 but the resinous magnetic ring 12 is embedded in the inner circumferential surface of a synthetic resin ring 12 instead of the outer circumferential surface thereof. According to this embodiment, the ring 1 is fitted into a hole, as denoted by numeral 1' in Figure 1, at its outer circumferential surface.

The embodiment shown in Figure 30 is similar to that shown in Figure 26 but the resinous magnetic ring 12 is embedded in the inner circumferential surface of a synthetic resin ring 12 instead of the outer circumferential surface thereof. According to this embodiment, the ring 1 is fitted into a hole, as denoted by numeral 1' in Figure 1, at its outer circumferential surface, and the metallic ring 14 attached to the inner circumferential surface protects the resinous magnetic ring 12 on one hand and reinforces the ring 1 against the stress arising for press fitting and other external causes. Since this metallic ring 14 is made of non-magnetic material such as aluminum, it allows passage of magnetic flux therethrough.

Figure 31 shows yet another embodiment of the present invention in which a plurality of gear teeth 12a are formed on an end surface of a ring 1 for detecting the rotation of an object and, therefore, a magnetic sensor 38 comprising an iron core 39 made of a permanent magnet and a coil 40 wound thereon is disposed adjacent to the end surface of the ring 1. Figures 32 and 33 show the ring 1 of Figure 31 in greater detail. According to this embodiment, a resinous magnetic ring 12 which is formed with a plurality of gear teeth 12a along its circumference is embedded in an end surface of a synthetic resin ring 13. If desired, the resinous magnetic ring 12 may be trapezoidal in cross section for positive attachment to the synthetic resin ring 1.

Figures 34 and 35 show yet another embodiment of the present invention. A ring 1 for detecting the rotation of an object according to the present invention comprises a resinous magnetic ring 12 which is made of synthetic resin such as polyamide and ferromagnetic powder such as ferrite dispersed therein and is provided with plurality of gear teeth along its outer circumferential surface. The toothed outer circumferential surface of the resinous magnetic ring 12 is surrounded by a metallic ring 14 for reinforcement. Since this metallic ring 12 reduces the deformation of the ring 1 when being press fitted, the resinous magnetic ring 12 is protected from any deterioration from excessive deformation. This metallic ring 14 is also helpful in preventing a foreign material to be caught in the gap between the teeth 12a or between the the teeth 12a and a magnetic sensor. If desired, this whole assembly may be enclosed in synthetic resin material. Since this metallic ring 14 is made of non-magnetic material, it does not substantially affect the pattern of the magnetic field.

Figures 36 and 37 show an embodiment which is similar to that shown in Figures 34 and 35 but differs therefrom in that the gear teeth 12a are formed in the end surface, instead of the outer surface, of the resinous magnetic ring 12.

Figures 38 and 39 show another similar embodiment according to the present invention. A ring 1 for detecting the rotation of an object according to the present invention comprises a resinous permanent magnet ring 2 which is made of synthetic resin such as polyamide and ferromagnetic powder such as ferrite dispersed therein and is magnetized to have alternative magnetic poles along its circumference. The outer circumferential surface of the resinous permanent magnet ring 2 is surrounded by a metallic ring 4 for reinforcement. Since this

metallic ring 4 is made of non-magnetic material, it does not substantially affect the pattern of the magnetic field. If desired, this whole assembly may be enclosed in synthetic resin material. This ring 1 may be fitted either onto a shaft as denoted by numeral 1 in Figure 1 or into a bore as denoted by numeral 1' in Figure 1..

In the embodiments shown in Figures 40 and 41, a metallic ring 14 having an L-shaped cross-section is attached to the outer circumferential and end surface of a resinous magnetic ring 12 having a plurality of gear teeth 12a around their outer circumferential surface and end surface, respectively. These rings 1 are adapted to be fitted into a bore as denoted by numeral 1' in Figure 1 at their outer circumferential surfaces.The embodiment of Figure 42 is similar to that shown in Figure 40 but has a resinous permanent magnet ring 2, which is magnetized to have alternating magnetic poles around its circumferential surface, instead of a resinous magnetic ring having gear teeth.

The embodiments shown in Figures 43, 44 and 45 are similar to those shown in Figures 40, 41 and 42, respectively, but four metallic segments 14, which are shaped like a letter C in cross-section, make up a ring which covers not only the outer circumferential surface and one of the end surfaces of resinous magnetic rings 12 (Figures 43 and 44) and a resinous permanent magnet ring 2 (Figure 45), respectively, but also the other end surfaces thereof.

The embodiments shown Figures 34 to 45 are adapted to be fitted into a bore as denoted by numeral 1' in Figure 1, and the metallic rings ', '' ensure the mechanical strength that is required for press fitting.

According to the embodiments shown in Figures 46, 47 and 48, metallic rings 14, 4 for reinforcement are attached only to the inner circumferential surfaces of resinous magnetic rings 12 - (Figures 46 and 47) and a resinous permanent magnet ring 2 (Figure 48), respectively.

The embodiments shown in Figures 49, 50 and 51 are similar to those shown in Figures 46, 47 and 48, respectively, but metallic rings 14, 4 which are L-shaped in cross-section cover not only the inner circumferential surfaces of resinous magnetic rings 12 (Figures 49 and 50) and a resinous permanent magnet ring 2 (Figure 51), respectively, but also one of the end surfaces thereof.

The embodiments shown in Figures 52, 53 and 54 are similar to those shown in Figures 49, 50 and 51, respectively, but metallic rings 14, 4 which are C-shaped in cross-section cover not only the inner circumferential surfaces and one of the end surfaces of resinous magnetic rings 12 (figures 52 and 53) and a resinous permanent magnet ring 2 - (Figure 54), respectively, but also the other end surfaces thereof.

The embodiments shown in Figures 49 to 54 are adapted to be fitted onto a shaft as denoted by numeral 1 in Figure 1, and the metallic rings 14, 4 ensure the mechanical strength that is required for press fitting.

According to the embodiments shown in Figures 55, 56 and 57, metallic rings 14, 4 cover both the inner and outer circumferential surfaces and one of the end surfaces of resinous magnetic rings 12 (Figures 49 and 50) and a resinous permanent magnet ring 2 (Figure 51), respectively. These embodiments are adapted to be fitted either onto a shaft or into a bore as denoted by numerals 1 or 1', as the case may be, in Figure 1, and the metallic rings 14, 4 ensure the mechanical strength that is required for press fitting.

Figures 58, 59 and 60 show different embodiments in which the inner circumferential surfaces of resinous magnetic rings 12 are provided with gear teeth 12a, and metallic rings 14 cover only the outer circumferential surface, or such surface and one or both of the end surfaces, of the resinous magnetic ring 12.

Figure 61, 62 and 63 show yet more embodiments of the present invention in which metallic rings 14, 4 cover only one end surface of a resinous magnetic ring 12 (Figures 61 and 62) or a resinous permanent magnet ring 2 (Figure 63), respectively. These embodiments are adapted to be fitted either onto a shaft or into a bore as denoted by numerals 1 or 1', as the case may be, in Figure 1, and the metallic rings 14, 4 ensure the mechanical strength that is required for press fitting.

Figure 64 shows yet another embodiment of the present invention. A resinous magnetic ring 32 of this embodiment consists of a pair of semi circular halves 32a and 32b which can be combined into a complete ring having a plurality of gear teeth 32c along its outer circumferential surface. These two halves of the ring 1 are held in place on a shaft S (shown in imaginary lines in Figures 64 and 65) with a metallic ring 24 which substantially covers the outer circumferential and end surface of the ring 1 as shown in Figure 65.

Figures 66 and 67 show embodiments which are similar to that of Figures 64 and 65 but the embodiment of Figure 66 has a resinous permanent magnet ring 22 which is magnetized into alternating magnetic poles along its circumference instead of a toothed magnetic ring and the embodiment of Figure 67 has a toothed magnetic ring 22 having a plurality of gear teeth 22c around its end surface instead of its outer circumferential surface.

The embodiment shown in Figure 68 comprises a synthetic resin ring 33 having an annular extension 33a and fitted onto a shaft S, a toothed resinous magnetic ring 32 embedded in the outer circumferential surface of the synthetic resin ring 33 and a metallic ring 24 which is similar to those shown in Figures 64 to 67 press fitted onto an annular extension 33a of the synthetic resin ring 33. The synthetic resin ring 33 as well as the toothed resinous magnetic ring 32 consist of a pair of semicircular halves, and the metallic ring 24 press fitted onto the extension 33a holds them together.

The embodiment shown in Figure 69 is similar to that shown in Figure 68 but has a resinous permanent magnet ring 22 which is magnetized to have alternating magnetic poles around its circumference, instead of a toothed ring, and is embedded in the outer circumferential surface of a synthetic resin ring 23. According to the embodiment shown in Figure 70, a toothed resinous magnetic ring 32 having a plurality of gear teeth 32c around its end surface is embedded in an end surface of a synthetic resin ring 33 which is otherwise similar to that shown in Figure 68.

The embodiment shown in Figure 71 comprises a synthetic resin ring 33 consisting of a pair of semi circular halves 33a and 33b and a resinous magnetic ring 32 which is provided with gear teeth 32c around its inner circumferential surface and likewise consists of a pair of semicircular halves 32a and 32b which are embedded in the corresponding halves 33a and 33b of the synthetic resin ring 33. This ring 1 for detecting the rotation of an object is adapted to be press fitted into a bore B. The embodiment shown in Figure 72 is similar to that shown in Figure 71 but differs therefrom only in that it comprises a resinous permanent magnet ring 22 which is magnetized to have alternating magnetic poles around its circumference, instead of a toothed magnetic ring.

According to the embodiment shown in Figure 73,, the ring 1 for detecting the rotation of an object comprises a synthetic resin ring 33 consisting of a pair of semi circular halves 33a and 33b and a resinous magnetic ring 32 which is provided with gear teeth 32c around its outer circumferential surface and likewise consists of a pair of semicircular halves 32a and 32b which are embedded in the corresponding halves 33a and 33b of the synthetic resin ring 33. Furthermore, the synthetic resin ring 33 is provided with a plurality of axial through holes 35 and can be secured to a shoulder surface F with threaded bolts 36 passed through these holes 35. According to this embodiment, the ring 1 is fitted onto a shaft S but need not be tightly fitted as was the case in previous embodiments.

The embodiment shown in Figure 74 is similar to that shown in Figure 73 but differs therefrom only in that it comprises a resinous permanent magnet ring 22 which is magnetized to have alternating magnetic poles around its circumference, instead of a toothed magnetic ring.

The embodiments shown in Figures 75 and 76 are similar to those shown in Figures 73 and 74, respectively, but differ therefrom in that they are fitted into bores B, instead of being fitted onto shafts.

Figure 77 shows an embodiment of a metallic ring 24 which can be used to fasten together a pair of halves into a complete ring by tightening a screw 24a which is passed through the two ends of the metallic ring 24. This metallic ring 24 can be conveniently applied to the embodiments shown in Figures 67 to 70.

Figure 78 is a plan view of a ring 1 for generating a magnetic signal in which the inner circumferential surface 37 of a synthetic resin ring 3 is formed into a polygonal shape so as to prevent a relative free rotation between the ring 1 and a corresponding member for press fitting.

Since the ring for generating a magnetic signal according to the present invention makes use of resinous material, it is suitable for mass production and light in weight, and, since it is reinforced by a ring member which has a great mechanical strength, it would not be damaged when press fitted. Furthermore, since the pressure it exerts upon a rotating member after press fitting is appropriate, the rotating member will be not deformed and no great care is necessary for adjusting the dimensions involved in press fitting, thereby improving the facility of manufacture.

It will thus be seen that the present invention, at least in its preferred forms, provides a ring having a magnetically alternating property along its circumference which is inexpensive to manufacture and is yet durable and reliable, and which is easy to install.

It is to be clearly understood that there are no particular features of the foregoing specification, or of any claims appended hereto, which are at present regarded as being essential to the performance of the present invention, and that any one or more of such features or combinations thereof may therefore be included in, added to, omitted from or deleted from any of such claims if and when amended during the prosecution of this application or in the filing or prosecution of any divisional application based thereon.

Claims

1. A ring (1, 1') to be attached to a rotary body (42) for producing a magnetic signal in cooperation with a magnetic sensor (38) relative to which the rotary body rotates, comprising:

a magnetic ring member (2, 12, 22, 32) having an alternating magnetic property around a circumference thereof and made of synthetic resin in which magnetic material is dispersed; and

a reinforcing ring member (3, 13, 23, 33) which is made of synthetic resin material and is substantially circumferentially coextensive with the magnetic ring member.

2. A ring as claimed in claim 1, wherein the magnetic ring member (2, 22) is magnetized to have alternating magnetic poles around its said circumference.

3. A ring as claimed in claim 1, wherein the magnetic ring member (12, 32) is provided with a plurality of teeth (12a, 32c) around its said circumference.

4. A ring as claimed in any of claims 1 to 3, wherein the magnetic ring member (2, 12, 22, 32) is embedded in the reinforcing ring member (3, 13, 23, 33) in a partially exposed state.

5. A ring as claimed in claim 4, which is further reinforced by a metallic ring (4, 14, 24) which covers the exposed surface of the magnetic ring member.

6. A ring as claimed in any of claims 1 to 3, wherein the magnetic ring member (2, 12) is wholly enclosed in the reinforcing ring member (3, 13).

7. A ring as claimed in any of claims 1 to 3, wherein the reinforcing ring member (3, 13, 23, 33) comprises a main body and an extension (3a, 13a, 23a, 33a), the main body carrying the magnetic ring member while the extension is adapted to be fitted to the rotary body.

8. A ring as claimed in any of claims 1 to 3, wherein the magnetic ring member is embedded in the reinforcing ring member with a buffer member - (5, 15, 25, 35) interposed therebetween.

9. A ring as claimed in any preceding claim, wherein a circumferential surface (37) of the ring for attachment to the rotary body is shaped as a polygonal surface.

10. A ring (1, 1') to be attached to a rotary body (42) for producing a magnetic signal in cooperation with a magnetic sensor (38) relative to which the rotary body rotates, comprising:

a magnetic ring member (2, 12, 22, 32) having an alternating magnetic property around a circumference thereof and made of synthetic resin in which magnetic material is dispersed; and

a reinforcing ring member (4, 14, 24) which is made of metal or alloy material and is substantially circumferentially coextensive with the magnetic ring member.

11. A ring as claimed in claim 10, wherein the magnetic ring member (2, 24) is magnetized to have alternating magnetic poles around its said circumference.

12. A ring as claimed in claim 10, wherein the magnetic ring member (12, 33) is provided with a plurality of teeth (12a, 32c) around its said circumference.

13. A ring as claimed in any preceding claim, wherein at least one of said ring members is made up of a plurality of arcuate segments.

14. A ring (1, 1') to be attached to a rotary body (42) for producing a magnetic signal in cooperation with a magnetic sensor (38) relative to which the rotary body rotates, comprising:

a magnetic ring member (22, 32) having an alternating magnetic property around a circumference thereof and which comprises at least two arcuate segments (22a, 22b, 32a, 32b) forming a complete circle through mutual cooperation therebetween, and made of synthetic resin in which magnetic material is dispersed; and

fastening means (24, 36) holding the arcuate segments together as a complete ring.

15. A ring as claimed in claim 14, wherein the said fastening mean comprises a reinforcing ring - (24) which extends wholly around a circumferential surface of the magnetic ring member.

16. A ring as claimed in claim 14 or 15, wherein the magnetic ring member is reinforced by reinforcing arcuate segment members (23a, 23b, 33a, 33b) made of synthetic resin which substantially surround the arcuate segments of the magnetic ring member.

17. A ring as claimed in claim 16, wherein each of the said reinforcing arcuate segment members - (23a, 23b, 33a, 33b) comprises a main body and an extension (23c, 33c) each of which forms a part of a complete circle, and the arcuate segments of the magnetic ring member (22a, 22b, 32a, 32b) are embedded in the main bodies of the reinforcing arcuate segment members, while the said fastening means (24) extends around a circumferential surface of the said extensions of the reinforcing arcuate segment members.

Fig. 1

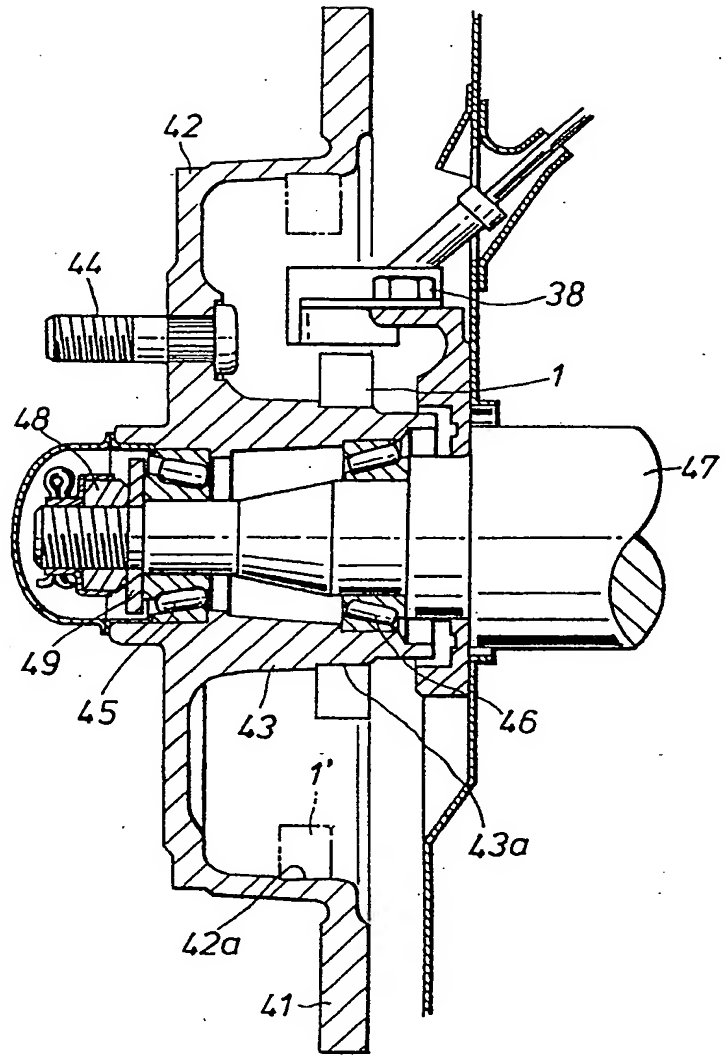


Fig. 2

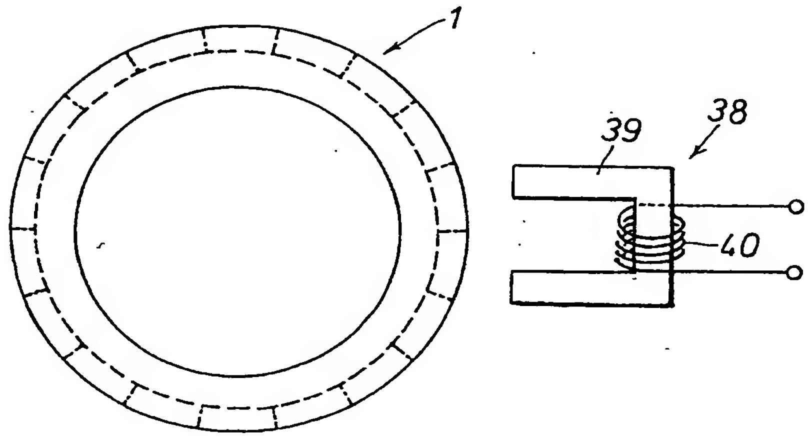


Fig. 3

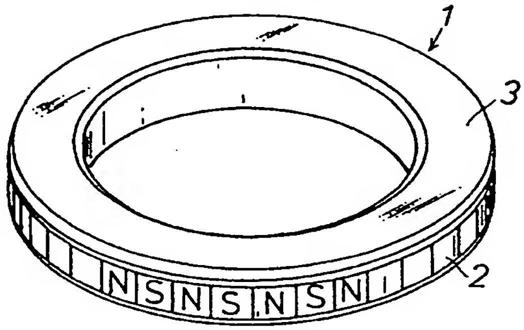


Fig. 4

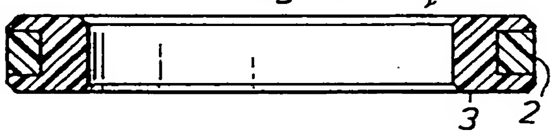


Fig. 5

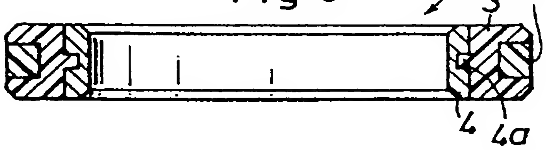


Fig. 6

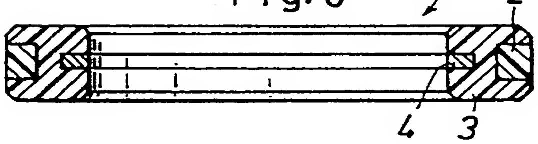


Fig. 7

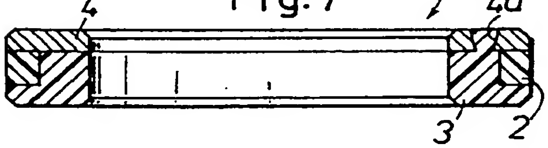


Fig. 8

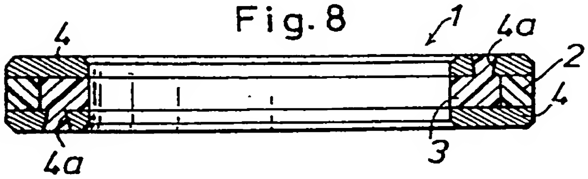


Fig. 9

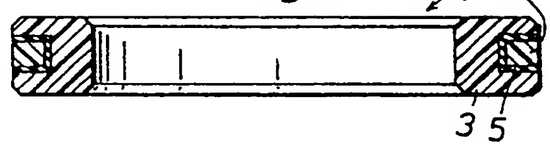


Fig. 10

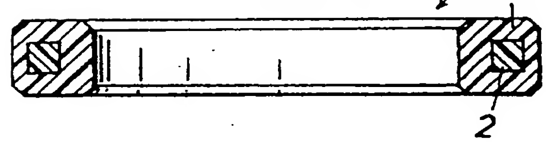


Fig. 11

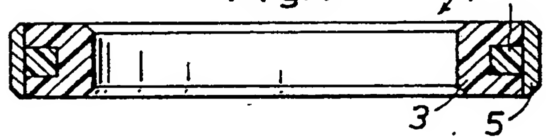


Fig. 12

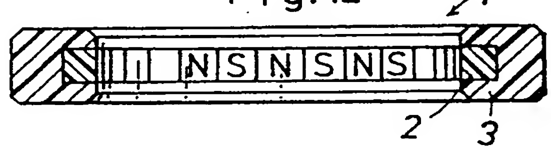


Fig. 13

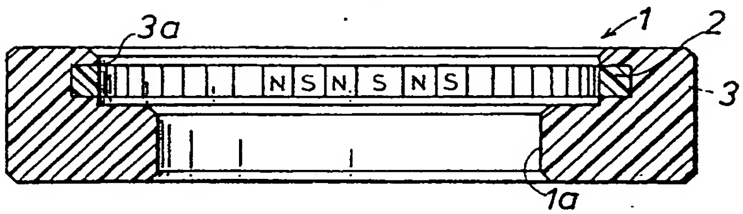


Fig. 15

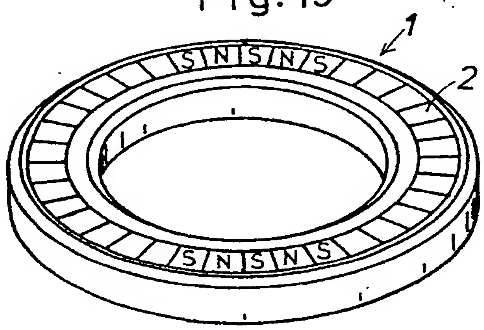


Fig. 14

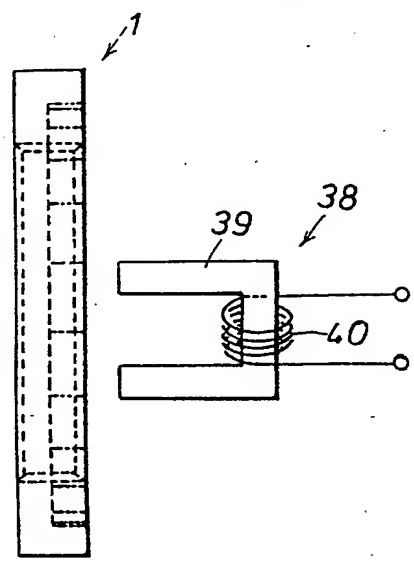


Fig. 16

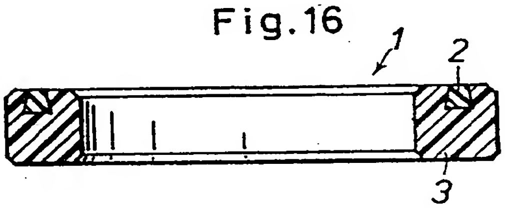


Fig. 17

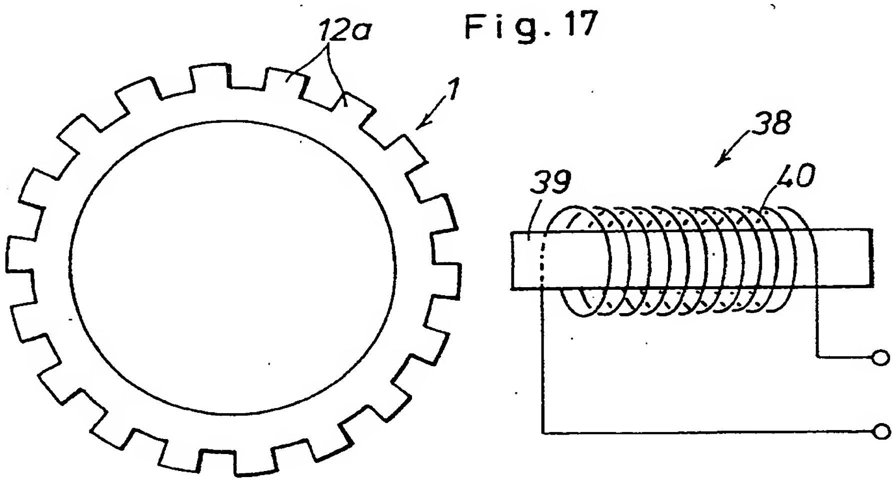


Fig. 18

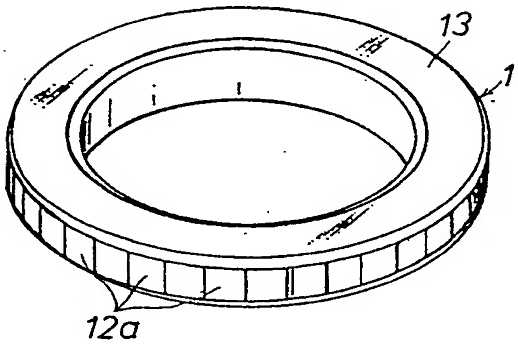


Fig. 19

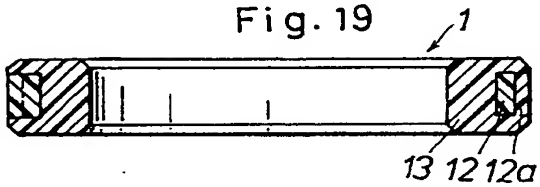


Fig. 20

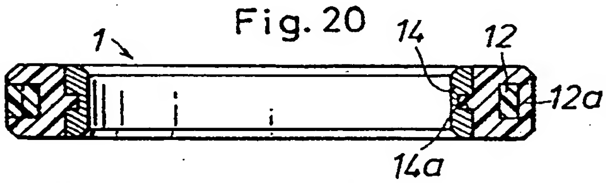


Fig. 21

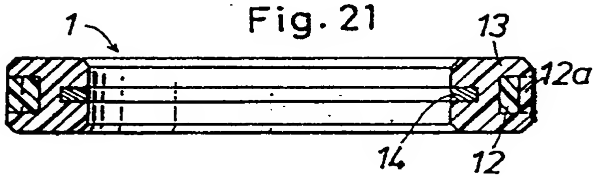


Fig. 22

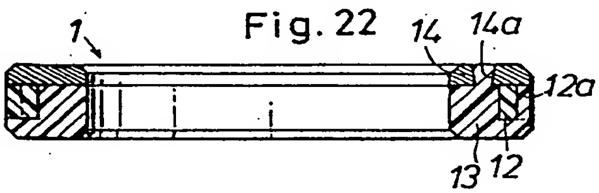
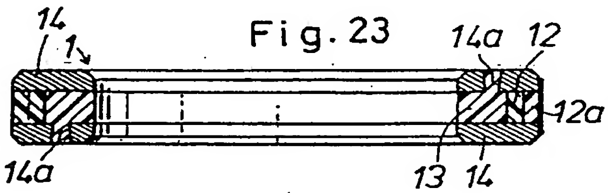


Fig. 23



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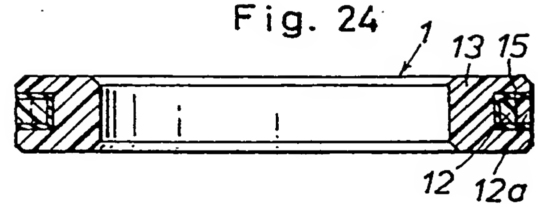


Fig. 25

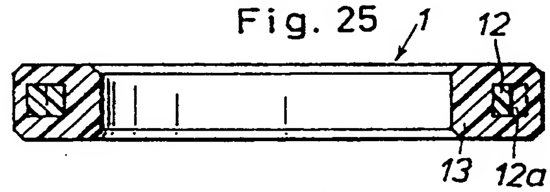
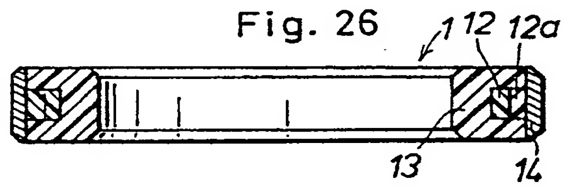


Fig. 26



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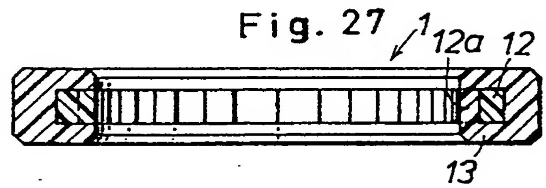

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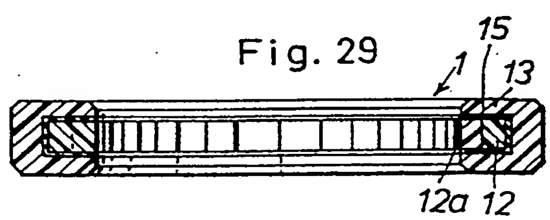


Fig. 30

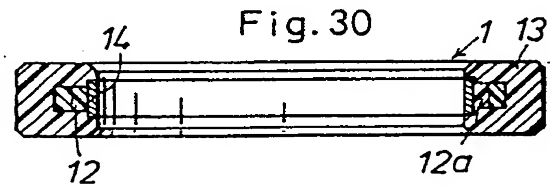


Fig.28

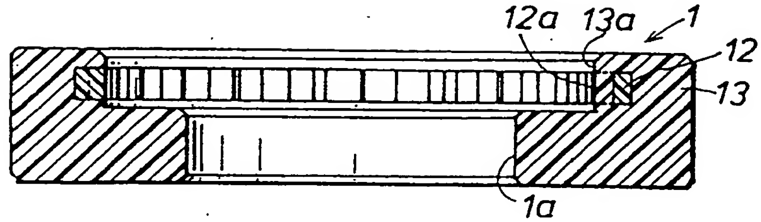


Fig.31

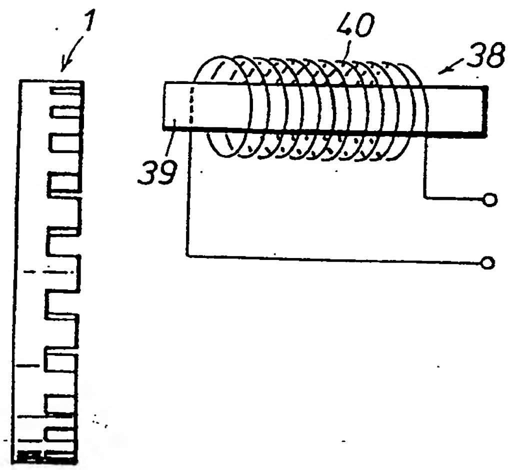


Fig.34

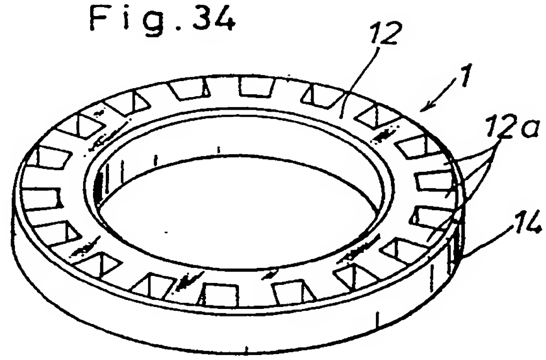


Fig.35

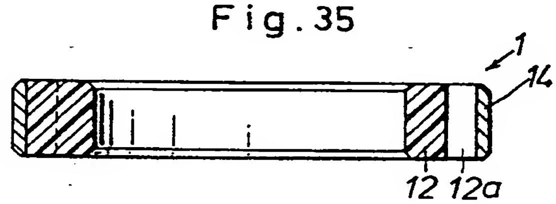


Fig.32

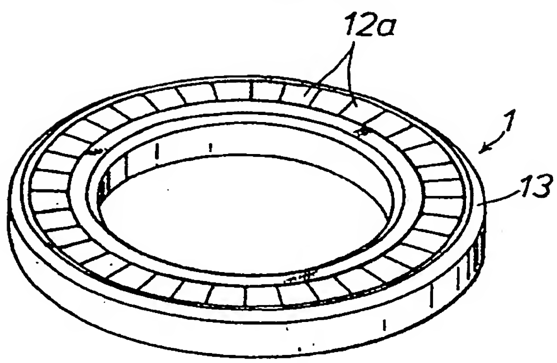


Fig.36

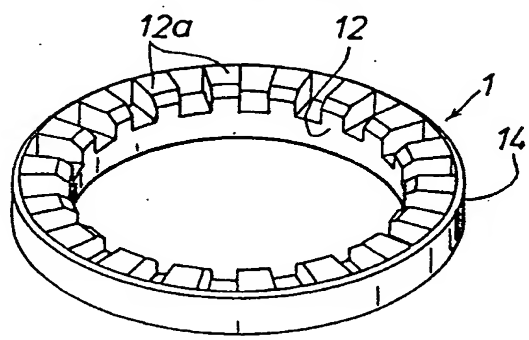


Fig.33

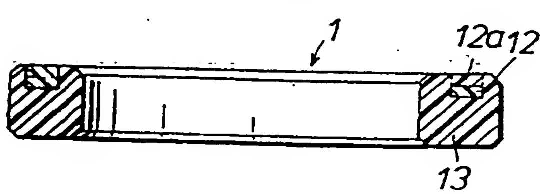


Fig.37

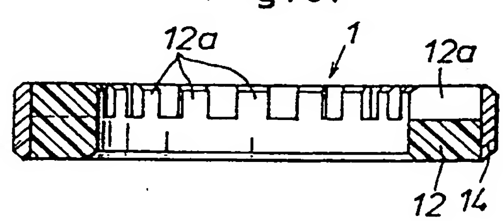


Fig.38

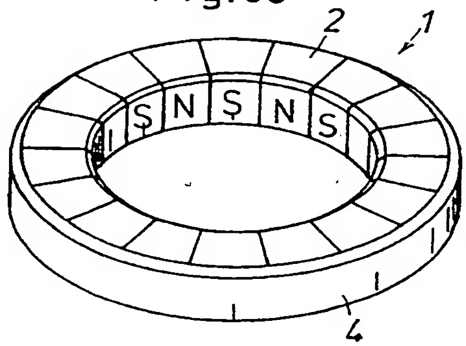


Fig.39

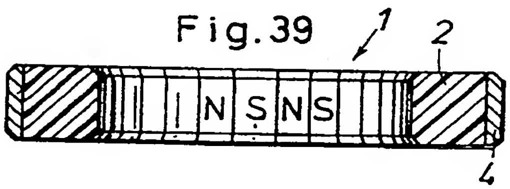


Fig.40

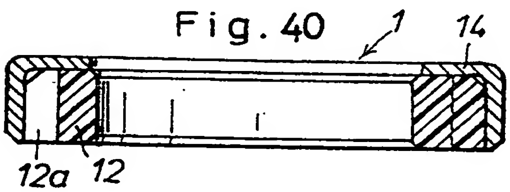
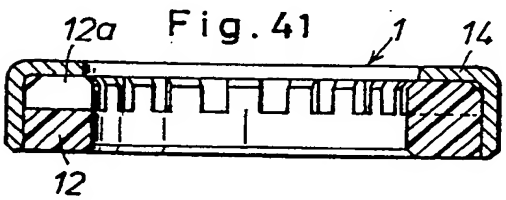


Fig.41



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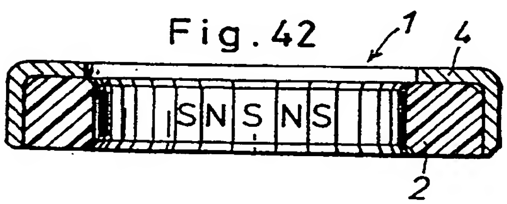

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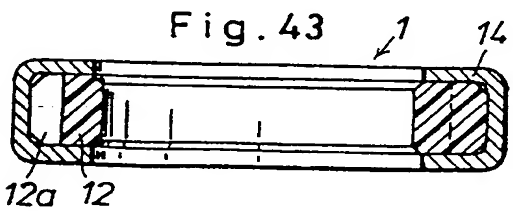
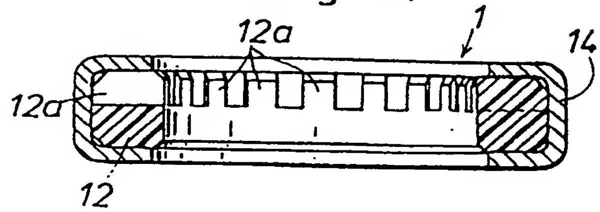


Fig.44



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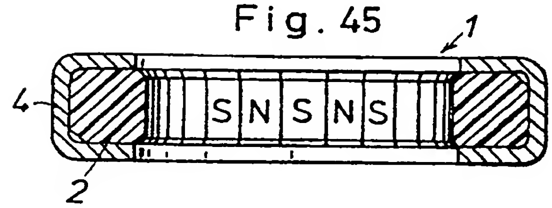

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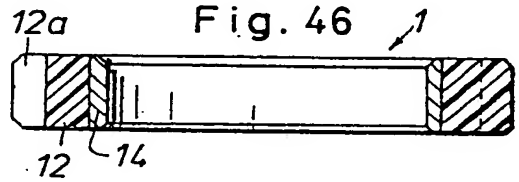


Fig.47

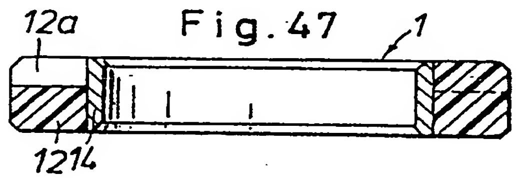


Fig.48

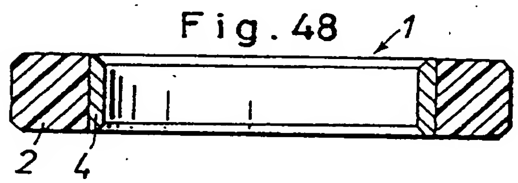


Fig.49

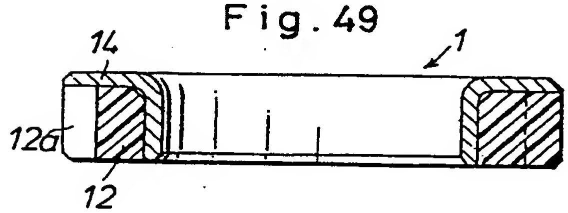


Fig.50

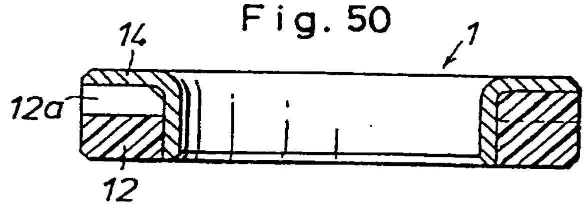


Fig.51

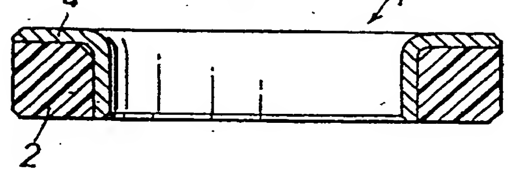


Fig.52

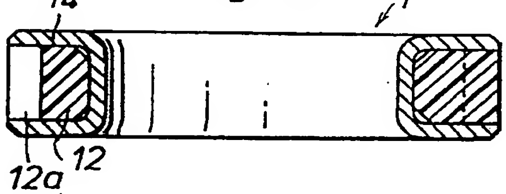


Fig.53

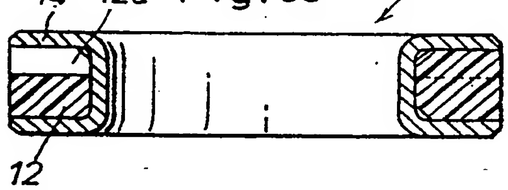


Fig.54

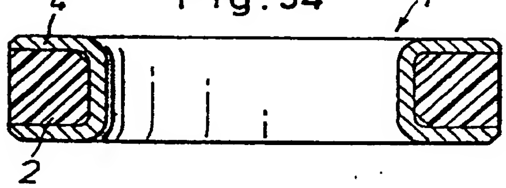


Fig. 55

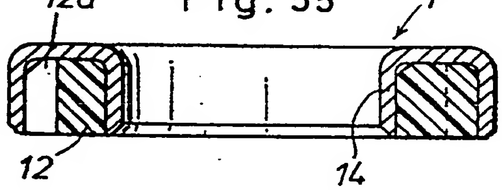


Fig. 56

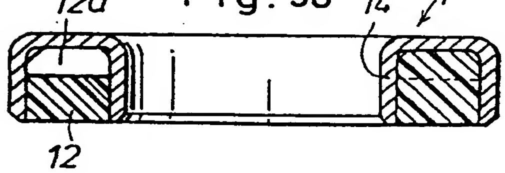


Fig.57

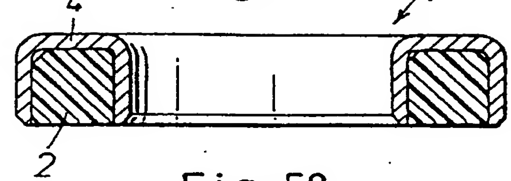


Fig.58

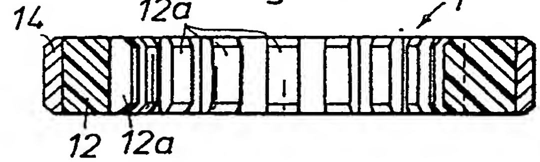


Fig. 59

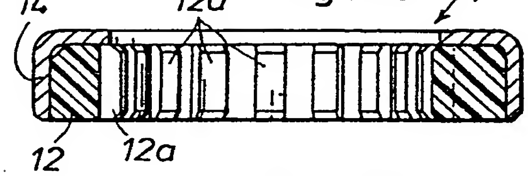


Fig.60

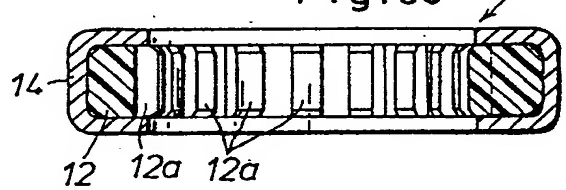


Fig.61

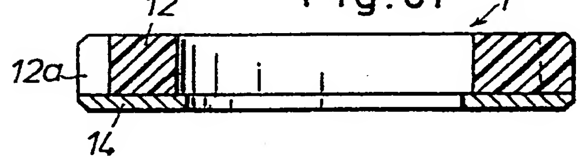


Fig. 62

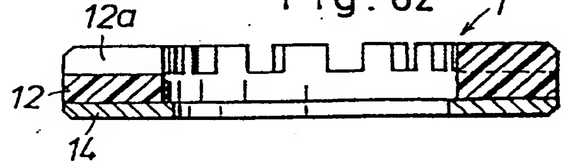


Fig.63

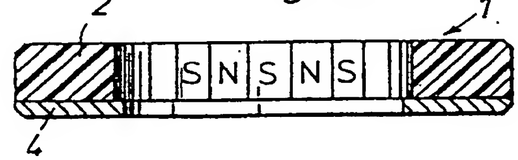


Fig. 64

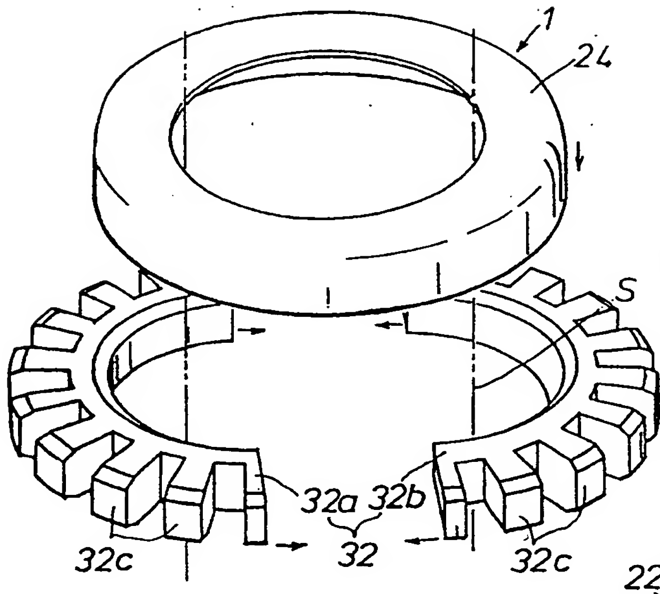


Fig. 65

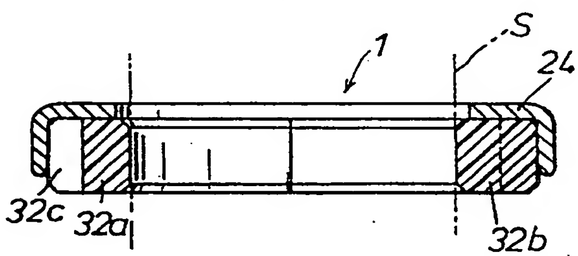


Fig. 66

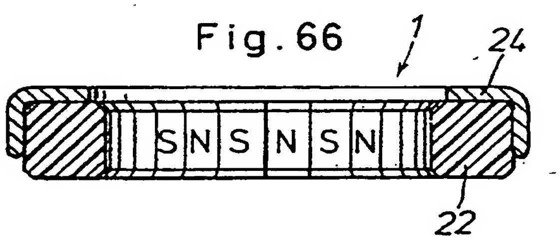


Fig. 67

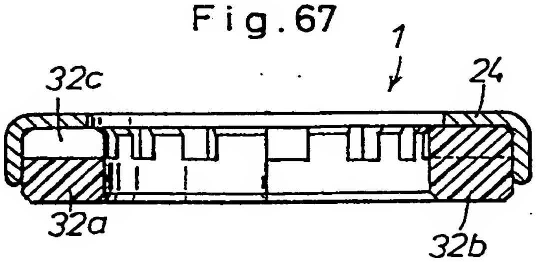
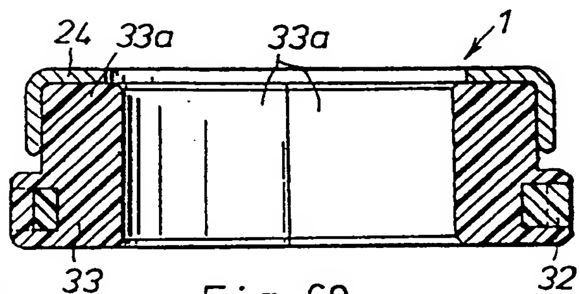


Fig. 68



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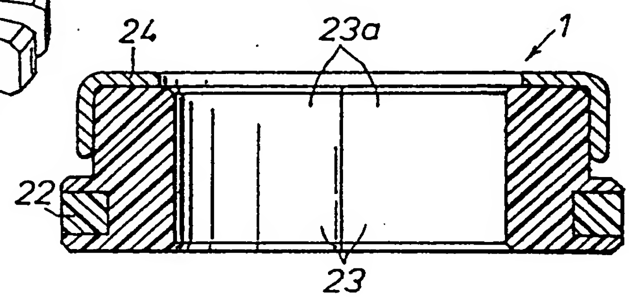
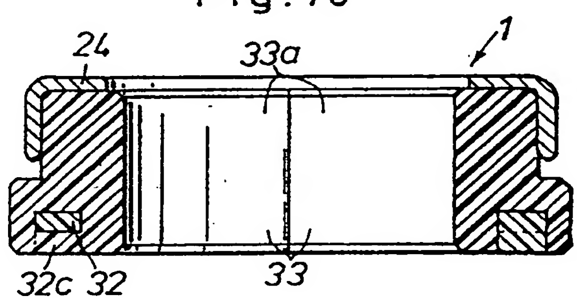


Fig. 70



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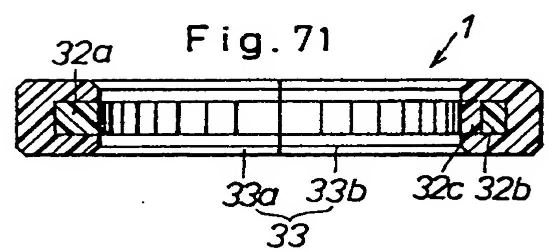

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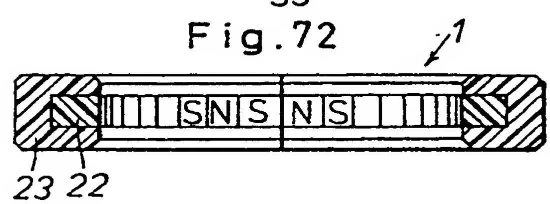

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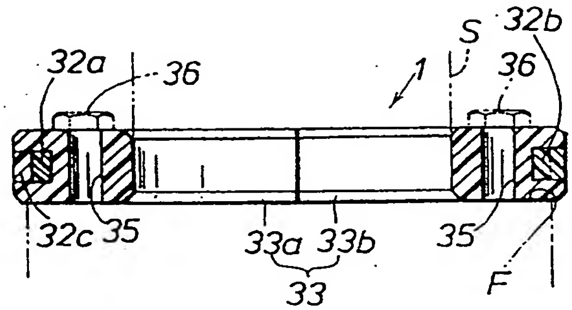

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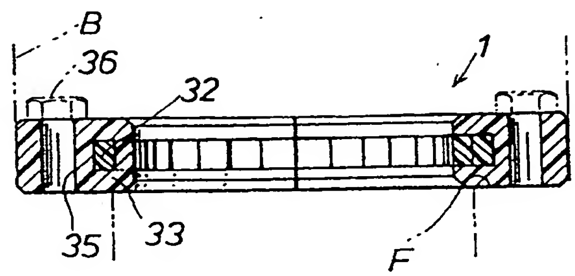


Fig.74

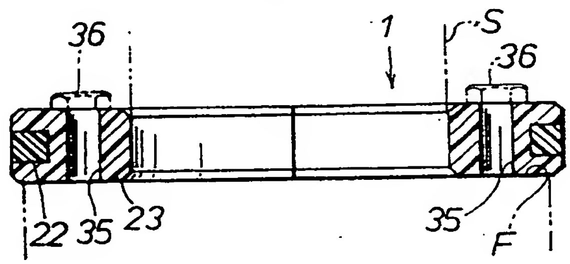


Fig.76

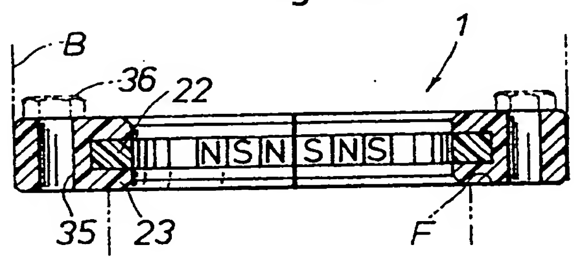


Fig.77

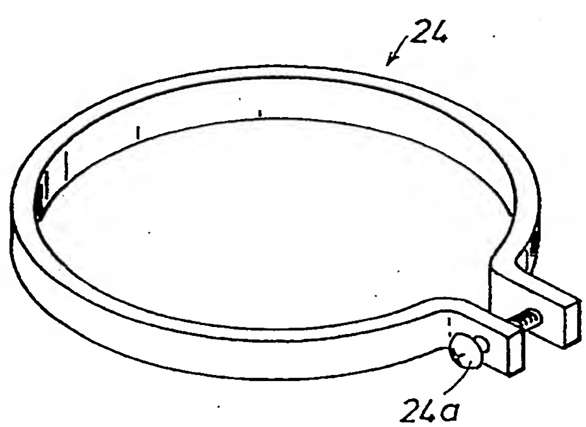
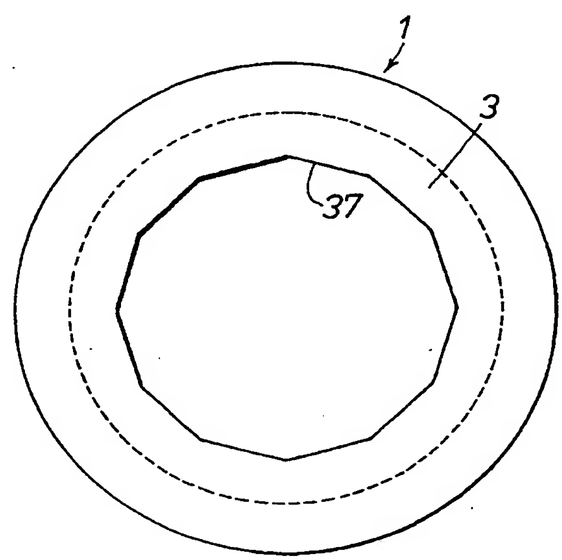


Fig.78



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EUROPEAN SEARCH REPORT

Application number

EP 86 30 5758

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Y	EP-A-0 081 225 (DAI-ICHI SEIKO CO. LTD.) * Page 6, lines 9-19; figures 4,5 * ---	1-6,10 -12,14 ,16,17	G 01 P 3/487 H 01 F 7/02 G 01 P 1/00
Y	CH-A- 295 518 (SIEMENS-SCHUCKERTWERKE) * Page 1, lines 28-36; page 2, lines 71-76; figures 1,4,5 * ---	1-6,10 -12	
Y	US-A-4 002 937 (J.H. ANSON) * Column 3, lines 50-68; figures 3-6 * ---	1,4,16 ,17	
A	PATENTS ABSTRACTS OF JAPAN, vol. 8, no. 10 (P-248)[1447], 18th January 1984; & JP-A-58 171 673 (NISSAN JIDOSHA K.K.) 08-10-1983 * Whole abstract * ---	8	TECHNICAL FIELDS SEARCHED (Int. Cl.4) G 01 P G 01 D H 01 F
A	DE-A-2 907 797 (NIPPON ELECTRIC CO. LTD.) * Page 15, lines 4-24; figures 3a-3f * ---	13	
A	US-A-3 781 592 (W.J. HARROLD) * Column 6, lines 29-35; figure 2 * -----	15	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	12-11-1986	HANSEN P.

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